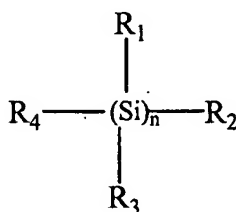


What is claimed is:

1. A method for treating a metal surface comprising:

- a) contacting the metal surface with an adhesion promotion composition to form a micro-roughened conversion coated metal surface, the adhesion promotion composition comprises a mixture of sulfuric acid and phosphoric acid; and then
- b) contacting the micro-roughened conversion coated metal surface with an aqueous organo-silicon composition to prepare the metal surface for receiving a polymer material.

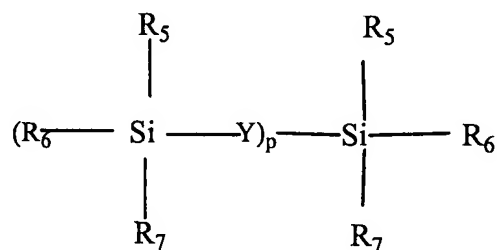
2. The method of claim 1, wherein the organo-silicon composition comprises an organosilane compound having the following formula:



where n is 1 or 2, and where R₁, R₂, R₃, and R₄, are, each independently, an alkyl of from 1 to 20 carbon atoms, straight-chained, branched or cyclic, the alkyl group may be substituted with an alkenyl group of 2 to 8 carbon atoms, a halogen, thiol, cyano, isocyanato, an epoxy group, glycidyl group, an acryloxy group, a primary, secondary, tertiary, or quaternary amino group, or an aryl group, the aryl group may have alkyl substituents of from C₁ to C₆, C₁ to C₆ alkoxy, a halogen, or a hydroxyl group; an alkenyl group of from 2 to 20 carbon atoms, straight, branched or cyclic, unsubstituted or substituted with a halogen, thiol, cyano, isocyanato, or a primary, secondary or tertiary amino group; an aryl group unsubstituted, or substituted with a halogen, hydroxyl, or an alkyl group having from 1 to 6 carbon atoms, the alkyl group may be substituted with a halogen, thiol, or primary, secondary, or tertiary amino group; an alkoxy group having from 1 to 6 carbon atoms, unsubstituted or substituted with a halogen, thiol, aryl, or primary, secondary or tertiary amino group; an epoxy substituted alkyl having from 3 to 12 carbon atoms; an acetamido group having from 2 to 6 carbon atoms; an aceto group having from 2 to 6 carbon atoms; acetoxy group; an imadazole group; a hydroxyl group; or a primary, secondary or tertiary amino group.

3. The method of claim 2, wherein the organosilane compound comprises trimethoxysilyl-propylethylene-diamine, trimethoxysilyl-propylene-diamine, trimethoxysilyl-propyldiethylene-triamine, N-methylamino-propyltrimethoxysilane, 3-mercaptopropyltrimethoxysilane, 3-mercaptopropylmethyldimethoxysilane, 2-mercptoethylmethyldiethoxysilane, isobutyl-trimethoxysilane, 3-isocaynatopropyl-triethoxysilane, 3-methacryloxy-propyltrimethoxysilane, N-methylamino-propyltrimethoxysilane, diphenyl-diethoxysilane, diphenyl-dimethoxysilane, 2-(3,4-epoxycyclohexyl)ethyl-trimethoxysilane, ethyl- triacetoxysilane, (3-gkycidooxypropyl-)-methyldiethoxysilane, 3-glycidopropyl-trimethoxysilane, chloromethyl-trimethylsilane, 3-chloropropyl-methyldimethoxysilane, 3-chloropropyl-triethoxysilane, 2-cyanoethyl-trimethoxysilane, di-t-butoxy-diacetoxysilane, hexamethyl-disilane, or mixtures thereof.

4. The method of claim 1, wherein the organo-silicon compound comprises an organosiloxane or organosilazane having the following formula:



where p is 1 to 6, Y is O, or NR₈, where R₈ is H, C₁ to C₈ alkyl or phenyl; and where R₅, R₆, and R₇ are, each independently, an alkyl group having from 1 to 20 carbon atoms, branched, unbranched, or cyclic, unsubstituted or substituted with halogen, or thiol; an alkenyl group of from 1 to 20 carbon atoms, branched or unbranched, unsubstituted or substituted with a halogen or thiol group; an aryl group, unsubstituted or substituted with an alkyl group of from 1 to 6 carbon atoms, an alkoxy group or a halogen, or hydroxyl group.

5. The method of claim 4, wherein the organosiloxanes comprise hexamethyl-disiloxane, 1,3-diphenyl-1,3-dimethyldisiloxane, 1,1,3,3-tetraisopropyl-disiloxane, 1,3-divinyl-tetramethyldisiloxane, 1,1,3,3-tetramethyl disiloxane, 1,1,3,3,5,5-hexamethyl-trisiloxane, decamethyl-tetrasiloxane, hexamethyl cyclotrisiloxane, decamethylcyclopentasiloxane, 1,3,5,7,9-pentamethylhydrocyclopentasiloxane or mixtures thereof.

6. The method of claim 4, wherein the silazanes comprise hexamethyldisilazane, 1,3-diphenyltetramethyldisilazane, 1,3-divinyldisilazane, 1,1,3,3,5,5-hexamethylcyclotrisilazane, octamethylcyclotetrasilazane, or mixtures thereof.

7. The method of claim 1, wherein the organo-silicon compound comprises from about 0.5% by volume to about 25% by volume of the aqueous composition.

8. The method of claim 7, wherein the organo-silicon compound comprises from about 5% to about 15% by volume of the aqueous composition.

9. The method of claim 1, wherein the micro-roughened conversion coated metal surface is contacted with the aqueous organo-silicon composition for about 1.0 second to about one minute.

10. The method of claim 9, wherein the micro-roughened conversion coated metal surface is contacted with the aqueous organo-silicon composition for about 10 to about 30 seconds.

11. The method of claim 10, wherein the adhesion promotion composition comprises an oxidizer, a corrosion inhibitor or mixtures thereof.

12. The method of claim 11, wherein the oxidizer comprises from about 0.1% to about 20% by weight of the adhesion promotion composition.

13. The method of claim 1, wherein the acid mixture comprises from about 5 to about 360 grams per liter of the adhesion promotion composition.

14. The method of claim 11, wherein the corrosion inhibitor comprises pyrroles, azoles, oxazoles, thiazoles, pyrazoles, triazoles, benzotriazoles, tetrazoles, tolyltriazoles, hydroxy-substituted azole compounds, imidazoles, benzimidazoles or mixtures thereof.

15. The method of claim 14, wherein the corrosion inhibitor comprises from about 0.1 to about 20% by weight of the adhesion promotion composition.

16. The method of claim 11, further comprising a source of halide ions.

17. The method of claim 16, wherein the source of halide ions comprises sodium chloride, potassium chloride, sodium chlorate, potassium chlorate, hydrochloric acid or mixtures thereof.

18. The method of claim 11, further comprising a non-surfactant amine, a quaternary ammonium compound or mixtures thereof.

19. The method of claim 18, wherein the non-surfactant amines comprise primary, secondary or tertiary amines having C₁ to C₈ substitution.

20. The method of claim 18, wherein the amines and the quaternary ammonium compounds comprise from about 0.01% to about 2.5% by weight of the adhesion promotion composition.

21. The method of claim 11, wherein the adhesion promotion composition is free of surfactants.

22. The method of claim 1, further comprising the step of placing a polymeric material on the micro-roughened conversion coated metal surface after post-treatment of the metal surface with the aqueous organo-silicone composition.

23. The method of claim 1, wherein the metal surface is copper or a copper alloy.

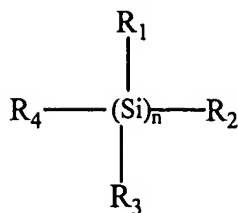
~~24.~~ A method for treating a metal surface comprising:

a) contacting the metal surface with an adhesion promotion composition to form a micro-roughened conversion coating on the metal surface, the adhesion promotion composition comprises an oxidizer, a corrosion inhibitor and a mixture of sulfuric acid and phosphoric acid;

b) contacting the micro-roughened conversion coated metal surface with an alkaline composition; and then

c) contacting the micro-roughened conversion coated metal surface with an aqueous organo-silicon wetting composition to prepare the micro-roughened conversion coated metal surface to receive a polymer material.

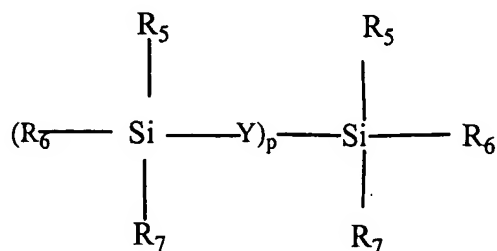
25. The method of claim 24, wherein the organo-silicon compounds comprise organosilanes having the following formula:



where n is 1 or 2, and where R₁, R₂, R₃, and R₄ are, each independently, an alkyl group of from 1 to 20 carbon atoms, straight-chained, branched or cyclic, the alkyl group may be substituted with an alkenyl of from 2 to 8 carbon atoms, a halogen, thiol, cyano, isocyanato group, an epoxy group, glycidyl group, an acryloxy group, a primary, secondary, tertiary, or quaternary amino group, or an aryl group, the aryl group may have alkyl substituents of C₁ to C₆, a C₁ to C₆ alkoxy, a halogen, or a hydroxyl group; an alkenyl group of from 2 to 20 carbon atoms, straight, branched, or cyclic, unsubstituted or substituted with a halogen, thiol, cyano, isocyanato group, a primary, secondary, or tertiary amino group; an aryl group, unsubstituted or substituted with a halogen, hydroxyl, an alkyl group or alkoxy group having from 1 to 6 carbon atoms, the alkyl group may be substituted with a halogen, thiol, cyano, isocyanato, or a primary, secondary or tertiary amino group; an alkoxy group having from 1 to 6 carbon atoms, unsubstituted or substituted with a halogen, thiol, aryl, primary, secondary, or tertiary amino group; an epoxy substituted alkyl having from 3 to 12 carbon atoms; an acetamido group having from 2 to 6 carbon atoms; an aceto group having from 2 to 6 carbon atoms; an acetoxo group; an imidazole group; a hydroxyl group; or a primary, secondary, or tertiary amino group.

26. The method of claim 25, wherein the organosilane comprises trimethoxysilyl-propyldiethylenetriamine, 1-trimethoxysilyl-2(chloromethyl)-phenylethane, N-trimethoxysilyl-N, N, N-tri-methyl ammonium chloride, trimethylethoxy-silane, trimethylsilyl-acetamide, trimethylsilyl-acetate, trimethylsilyl-imidazole, isobutyl-trimethoxysilane, 3-isocyanatopropyl-triethoxysilane, 3-mercaptopropyl-trimethoxysilane, 3-methacryloxypropyl-methoxysilane, N-methylaminopropyl-trimethoxysilane, Diphenyl-diethoxysilane, diphenyl-dimethoxysilane, 2-(3,4-epoxycyclohexyl)ethyl-trimethoxysilane, ethyltriacetoxysilane, (3-glycidoxypropyl)-methyldiethoxysilane, 3-glycidoxypropyl-trimethoxysilane, chloromethyl-trimethylsilane, 3-chloropropyl-methyldimethoxysilane, 3-chloropropyl-trimethoxysilane, 3-chloropropyl-trimethoxysilane, 2-cyanoethyl-trimethoxysilane, di-t-butoxy-diactoxysilane, hexamethyl-disilane, diphenyl-silanediol, or mixtures thereof.

27. The method of claim 24, wherein the organo-silicon compound comprises organosiloxanes or organosilazanes having the following formula:



where p is 1 to 6, Y is O or NR₈; R₈ is H, C₁ to C₈ is alkyl, or phenyl; and where R₅, R₆, and R₇, are, each independently, an alkyl group having from 1 to 20 carbon atoms, branched, unbranched, or cyclic, unsubstituted or substituted with halogen, or thiol; an alkenyl group of from 1 to 20 carbon atoms, branched or unbranched, unsubstituted or substituted with a halogen or thiol group; an aryl group, unsubstituted or substituted with an alkyl group of from 1 to 6 carbon atoms, an alkoxy group or a halogen or hydroxyl group.

28. The method of claim 27, wherein the organosiloxanes comprise hexamethyldisiloxane, 1,3-diphenyl-1,3-dimethyldisiloxane, 1,1,3,3-tetraisopropyl-disiloxane, 1,3-divinyltetramethyldisiloxane, 1,1,3,3-tetramethyl-disiloxane, 1,1,3,3,5,5-hexamethyl-trisiloxane, decamethyl-tetrasiloxane, hexamethylcyclotrisiloxane, decamethylcyclopentasiloxane, 1,3,5,7,9-pentamethylhydrocyclopentasiloxane.

29. The method of claim 27, wherein the organo-silazane comprises hexamethyldisilazane, 1,3-diphenyltetramethyldisilazane, 1,3-divinyltetramethyldisilazane, 1,1,3,3,5,5-hexamethylcyclotrisilazane, octamethylcyclotetrasilazane or mixtures thereof.

30. The method of claim 24, wherein the organo-silicon compound comprises from about 0.5% by volume to about 25% by volume of the aqueous organo-silicon composition.

31. The method of claim 24, wherein the oxidizer comprises hydrogen peroxide, persulfates, or mixtures thereof.

32. The method of claim 24, wherein the corrosion inhibitor comprises triazoles, benzotriazoles, imidazoles, benzimidazoles, tetrazoles or mixtures thereof.

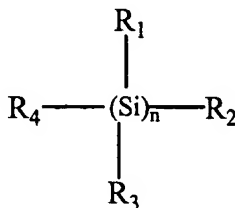
33. The method of claim 24, wherein the alkaline composition further comprises a source of halide ions.

34. The method of claim 24, further comprising the step of placing a polymer material on the micro-roughened conversion coated metal surface after contacting the metal surface with the organo-silicon aqueous composition.

~~35.~~ A method of treating a metal surface comprising:

- a) contacting the metal surface with an adhesion promotion composition to form a micro-roughened conversion coated surface on the metal surface and to reduce the metal surface, the adhesion promotion composition comprises a reducer, dissolution agent and a mixture of sulfuric acid and phosphoric acid;
- b) contacting the micro-roughened and reduced metal surface with an aqueous organo-silicon composition to prepare the micro-roughened and reduced metal surface for receiving a polymeric material.

36. The method of claim 35, wherein the aqueous organo-silicon composition comprises organosilanes having the following formula:

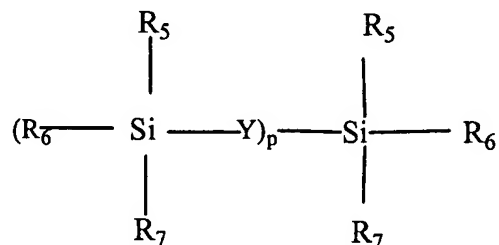


where n is 1 or 2, and where R₁, R₂, R₃, and R₄ are, each independently, an alkyl group of from 1 to 20 carbon atoms, straight-chained, branched or cyclic, the alkyl group may be substituted with an alkenyl group of from 2 to 8 carbon atoms, a halogen, thiol, cyano, isocyanato, an epoxy group, glycidyl group, an acryloxy group, a primary, secondary, tertiary or quaternary amino group, or an aryl group, the aryl group may have alkyl substituents of C₁ to C₆, a C₁ to C₆ alkoxy, a halogen or a hydroxyl group; an alkenyl group of from 2 to 20 carbon atoms, straight chained, branched, or cyclic, unsubstituted or substituted with a halogen, thiol, cyano, isocyanato, or a primary, secondary or tertiary amino group; an aryl group, unsubstituted or substituted with a halogen, hydroxyl, or an alkyl group having from 1 to 6 carbon atoms, the alkyl group may be substituted with a halogen, thiol, a primary, secondary, or tertiary amino group; an alkoxy group having from 1 to 6 carbon atoms, unsubstituted or substituted with a halogen, thiol, aryl, a primary, secondary, or tertiary amino group; an epoxy substituted alkyl

having from 3 to 12 carbon atoms; an acetamido group having from 2 to 6 carbon atoms; an aceto group having from 2 to 6 carbon atoms; an acetoxy group; an imidazole group; a hydroxyl group; or a primary, secondary or tertiary amino group.

37. The method of claim 36, wherein the organosilanes comprise amino-silanes, mercapto-silanes, alkyl-silanes, alkenyl-silanes, alkoxy-silanes or mixtures thereof.

38. The method of claim 35, wherein the aqueous organo-silicon composition comprises organosiloxanes or organosilazanes having the following formula:



where p is 1 to 6, Y is O or NR₈; R₈ is H, C₁ to C₈ alkyl, or phenyl; and where R₅, R₆, and R₇, are, each independently, an alkyl group having from 1 to 20 carbon atoms, branched, unbranched, or cyclic, unsubstituted or substituted with halogen, or thiol; an alkenyl group of from 1 to 20 carbon atoms, branched, or unbranched, unsubstituted, or substituted with a halogen or thiol group; an aryl group, unsubstituted, or substituted with an alkyl group of from 1 to 6 carbon atoms, an alkoxy group or a halogen, or hydroxyl group.

39. The method of claim 38, wherein the organosiloxane comprises hexamethylcyclotrisiloxane, hexamethyl-disiloxane, 1,3-divinyltetra-methyldisiloxane, decamethylcyclopentasiloxane, decamethyl-tetrasiloxane, or mixtures thereof.

40. The method of claim 38, wherein the organosilazane comprises 1,1,3,3,5,5-hexamethylcyclo-trisilazane, hexamethyldisilazane, or mixtures thereof.

41. The method of claim 35, wherein the aqueous organo-silicon composition comprises from about 0.5% to about 25% by volume of an organo-silicon compound.

42. The method of claim 35, wherein the reducer comprises aminoboranes, ammonium, alkali metal borohydrides, hypophosphites, alkaline earth metal borohydrides, alkaline earth metal hypophosphites, aldehydes, glyoxylic acid, reducing sugars, or mixtures thereof.

43. The method of claim 35, wherein the dissolution agents comprise EDTA, HEEDTA, NTA, DTPA, DCTA, ethoxylated/propoxylated ethylene diamine derivative, organic phosphanates, organic acids, inorganic acids, ammonium, amines, or mixtures thereof.

44. The method of claim 35, wherein the adhesion promotion composition further comprises a corrosion inhibitor.

45. The method of claim 44, wherein the corrosion inhibitor comprises azole, derivatives such as benzotriazole, tolyltriazole, or mixtures thereof.

46. The method of claim 35, further comprising the step of placing a polymeric material on the metal surface after treating the metal with the aqueous organo-silicon composition.

43
44
45
46